U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE BOTANIST

FOR

1892.

BY

GEORGE VASEY.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1892.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

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REPORT OF THE BOTANIST.

SIR: I have the honor of presenting herewith a report of the work of the Division of Botany for the year 1892. It contains a statement of the field investigations and expeditions, of the office work, of the botanical publications and bulletins, and an account of the experiments conducted in the cultivation of grasses and forage plants.

Respectfully,

GEORGE VASEY,
Botanist.

Hon. J. M. RUSK,
Secretary.

WORK OF THE YEAR.

The work of the Division of Botany has been conducted during the past year with great vigor. This work comes under the following heads:

(1) Botanical field investigations for a more complete knowledge of the vegetable products of little known localities.

(2) Office work in the determination of plants collected in the field, their preparation for the herbarium, and the distribution of duplicates among agricultural colleges and educational institutions.

(3) The publication of botanical bulletins both scientific and popular.

(4) The conducting of experiments on grasses and other forage plants in different parts of the country, particularly in the arid regions.

(5) Investigation of weeds.

FIELD WORK.

The field work during the past year has been much diminished on account of the reduced appropriations. An expedition was organized for the exploration of northwestern Idaho. The region of its operation was the headwaters of the Snake River from Lewiston eastward and northward, among the numerous mountain ranges of Bitterroot and Cœur de Alene, of the basaltic basins of the Clearwater and Pelouse rivers, and the country around the lakes Cœur de Alene and Pend d'Oreille.

This expedition was very successful, although attended with many difficulties and some dangers, and resulted in the collection of about 20,000 specimens, including trees, shrubs, herbs, grasses, and other herbaceous plants.

One agent was employed in Alaska. Our acquaintance with the flora of Alaska, except some points near the coast, has been meager, and

a more thorough investigation was extremely desirable. Accordingly an agent was sent to the southeastern part of Alaska to examine the flora of that region. An arrangement was made with the Superintendent of the U. S. Coast and Geodetic Survey, by which the agent was carried on the steamer *Hassler* from San Francisco to Yakutat Bay, in the vicinity of which his explorations were conducted during the season. Investigation was directed especially to the timber trees and grasses, a complete collection of which was transmitted to the Department.

Other field work was performed in various parts of California, of Arizona, of Texas, and of Florida. About 30,000 specimens were thus obtained.

OFFICE WORK.

The determination of the plants collected by the several field agents was a work requiring critical examination and occupied much time and expert labor. About 12,000 specimens were mounted and added to the herbarium, and over 15,000 specimens were distributed to agricultural colleges and other institutions of research. The amount of office work accomplished has been greater than during any previous year.

PUBLICATIONS.

The following publications have been issued during the year, in addition to the Annual Report of the Botanist for 1891:

Contributions from the U. S. National Herbarium. Vol. III. No. 1. Monograph of the Grasses of the United States and British America. By Dr. George Vasey. Issued Feb. 25, 1892. 8°. pp. v+89. Index.

Contributions from the U. S. National Herbarium. Vol. II. No. 2. Manual of the Phanerogams and Pteridophytes of Western Texas. By John M. Coulter. Issued June 1, 1892. 8°. pp. v+153–345. Index.

Contributions from the U. S. National Herbarium. Vol. I. No. 5. List of plants collected by Dr. Edward Palmer, in 1890, on Carmen Island. By J. N. Rose. List of plants collected by the U. S. S. *Albatross* in 1887–'91, along the western coast of America. By J. N. Rose, D. C. Eaton, J. W. Eckfeldt, and A. W. Evans. Revision of the North American species of Hoffmanseggia. By E. M. Fisher. Systematic and alphabetic index of new species of North American Phanerogams and Pteridophytes, published in 1891. By Josephine A. Clark. Issued Sept. 20, 1892. 8°. pp. v+129–188. Index.

Bulletin No. 13. Grasses of the Pacific Slope, including Alaska and the adjacent islands. Plates and descriptions of the grasses of California, Oregon, Washington, and the northwestern coast, including Alaska. By Dr. George Vasey. Part 1. Issued Oct. 20, 1892. Roy. 8°. pp. 7+[50]. 50 plates.

Contributions from the U. S. National Herbarium. Vol. I. No. 6. List of plants collected by C. S. Sheldon and M. A. Carleton, in the Indian Territory, in 1891. By J. M. Holzinger. Observations of the native plants of Oklahoma Territory and adjacent districts. By M. A. Carleton. Issued Dec. 6, 1892. 8°. pp. v+189–232. Index.

EXPERIMENTS ON GRASSES AND OTHER FORAGE PLANTS.

The experiment station at Garden City, Kansas, has been conducted during the past year with great energy and with pronounced success, as will be seen from the report following. On account of the reduction in the appropriation, the Department was under the necessity of discontinuing the assistance afforded to State experiment stations in the prosecution of grass experiments, except in the case of the three States of Georgia, Mississippi, and Louisiana. These were placed under the superintendence of Prof. S. M. Tracy, whose report is given below.

INVESTIGATION OF WEEDS.

During the summer so many complaints were received about the damage done in the Northwest by the Russian thistle (*Salsola kali* var. *tragus*), that the Secretary of Agriculture detailed Mr. L. H. Dewey, Assistant Botanist, to investigate the subject. His report, to be published as Farmers' Bulletin No. 10, describes the extent of this pest in North and South Dakota, Minnesota, and Iowa, estimates the damage done by it during 1892 at $2,000,000, and recommends as the principal remedies early fall plowing, the burning of stubble, and the raking and burning of the thistle in neglected fields.

THE GRASS EXPERIMENT STATION OF THE DEPARTMENT AT GARDEN CITY, KANSAS.

The present is the fourth year of this station, which was established for the purpose of conducting experiments to ascertain what grains and forage plants were adapted to cultivation in the arid and semiarid districts west of the one-hundredth meridian.

When the station was opened, only 8 or 10 acres of land was already plowed, and this had been neglected for several years until it had become overrun with weeds, the extermination of which cost much time and labor. The first year's work (1889) was principally devoted to breaking the native sod, sowing the seeds of the grasses which were selected for experiment, and inclosing the premises with a wire fence. A few acres was planted with various kinds of sorghum, imphee, and Kaffir corn, which, without irrigation, made a remarkable growth, some of the varieties reaching a height of 10 feet.

The Kaffir corn, although growing only 6 feet high, produced the largest proportion of foliage, and was estimated to yield at the rate of more than 20 tons of green feed to the acre.

A large part of the grass seeds failed to germinate, or died out soon after germination, but some ten or twelve kinds gave promise of persistence. In the fall of this year 40 acres of the newly plowed land was seeded to winter rye.

The second year (1890) about 50 acres was sowed with grass seed of fifteen kinds, about 12 acres devoted to other forage plants, such as sanfoin, spurry, serradilla, goats-rue, hairy vetch, Bokhara clover, and alfalfa, and about 8 acres to Polish wheat. Many other forage plants were cultivated in small plats.

The season was one of uncommon drought, there being only 13 inches of rainfall during the period from January 1 to October 25. In consequence, the result was disappointing as to a large part of the crops, especially as to the grasses. Five or six kinds, however, endured the drought remarkably well, and it was resolved to increase the cultivation of these in the future. The forage plants above mentioned suffered much, yet maintained life, and it was believed that they would do better during the following season. The Bokhara clover made a good crop, as it will undoubtedly do in the driest season. Notwithstanding the discouraging effects of the drought, there was some compensation in the fact that the winter rye did surprisingly well under the circumstances, and yielded a crop of 17 bushels per acre; but the 8 acres of Polish wheat, which up to June 1 was promising a heavy yield, was not able to fill the heads, and harvested at the rate of only 8 or 10 bushels per acre. Of the numerous varieties of sorghum which were planted, most were

failures on account of the drought and the desiccating winds; although one variety, called "Jerusalem corn," maintained much vigor and matured a fair crop of seed. This Jerusalem corn had been tried in other places with favorable results, and it is known to be quite as valuable as corn for fattening stock, and also to be very good as human food. Such quantities of the rye and wheat as could be spared from the wants of the station, were distributed among the farmers of the surrounding country for further experiments.

The third year (1891) 240 acres was in cultivation. Of this there was 20 acres of winter rye, 10 acres of Polish wheat, 50 acres of Jerusalem corn, and nearly 50 acres of other varieties of sorghum.

The early part of this season was remarkably dry, the rainfall from January 1 to May 21 amounting to only $1\frac{41}{100}$ inches; but the remainder of the season, up to October 3, gave a rainfall of over 23 inches, nearly 3 inches above the average.

All the crops suffered from the early drought, but nevertheless the winter rye yielded at the rate of 12 bushels per acre, the Polish wheat at the rate of 24 bushels, and the Jerusalem corn at the rate of 40 bushels. The 10 acres of alfalfa, which came near perishing the preceding year, recovered itself, yielded two cuttings of hay, and was growing vigorously at the close of the season. Several of the other forage plants gave evidence of hardiness and persistence.

Most of the grasses proved thrifty, the Hungarian brome, of which 6 acres was sowed, being particularly promising, and remaining green and vigorous until winter.

About 2,500 packages of Jerusalem corn were distributed to applicants. All the surplus of the other grains was also distributed in quantities varying from 2 ounces to 2 bushels. In all there was sent out 64 tons of seed.

The results of this year's experiments, which covered the important factors of depth of plowing and seeding, time of planting, and methods of cultivation, were considered very favorable.

Confirmatory reports have been received as to the seeds sent out to farmers for trial. The superintendent states that one man reports a yield of 86 bushels of rye from 2 bushels of seed sent to him; another, 84 bushels of Jerusalem corn from 5 pounds of seed; another, 10 bushels of Polish wheat from 15 pounds of seed. The superintendent further says: "People in this part of the country bless the experiment station, and declare that the Department of Agriculture has never before done anything that has so directly benefited the people."

We now come to the present year's work (1892). Dr. J. A. Sewall, the superintendent, reports as follows:

REPORT OF DR. J. A. SEWALL.

I beg leave to submit the following report relative to the work done and the results attained at this station during the year 1892:

The season has been remarkably dry and warm. The temperature for several days in August reached 104° F.

The rainfall up to November 7 has been below the average of seventeen years' observation, as will be seen from the following table:

	Inches.		Inches.
January	0.00	August	1.09
February	0.21	September	0.34
March	1.12	October	0.28
April	0.77	November 1 to 7	0.30
May	3.96		
June	2.27	Total rainfall during above period	13.97
July	3.63	Average yearly rainfall	20.21

The following is a list of the grasses, forage plants, and grains under cultivation this season, with the results:

GRASSES.

(1) Switchgrass, *Panicum virgatum*, 20 acres. This grass made a good growth, standing very evenly. Fifteen acres was cut early in the season, just as it was beginning to bloom, and yielded about 1½ tons to the acre of excellent hay. Five acres was left to mature as a seed crop, but, owing to the lack of rain, very few seeds matured—not enough to pay for threshing. (Plate I.)

(2) Hungarian brome, *Bromus inermis*, 5 acres. This most promising and valuable grass made a good growth notwithstanding the drought. It was cut as a seed crop and yielded 1,000 pounds of clean, first-class seed. This field was sowed in the spring of 1891. Another field of 20 acres sowed in the spring of the present year, 1892, made a very satisfactory growth and was as green in October as at any time during the season. It produced no seed, but next season, with the average rainfall, will probably yield 250 to 300 pounds of seed per acre. (Plate II.)

(3) Colorado blue-stem, *Agropyrum glaucum*, 10 acres. This grass was sowed in the spring of 1890. It made a good growth, standing much thicker than for the two previous seasons, and yielded about 1¼ tons per acre of excellent hay, particularly relished by horses, and apparently equal to that produced by the common grasses. (Plate III.)

(4) *Agropyrum tenerum*, 2 acres. In yield it was about equal to the *A. glaucum*, but does not stand the drought as well, and is not so good for hay; yet I think it a valuable and reliable crop for the plains.

(5) Indian grass, *Chrysopogon nutans*, 1 acre. The yield was excellent, about 2 tons to the acre. Cut early it makes an excellent hay, which is eaten with relish by horses, mules, and neat cattle. If left until seed matures, it is too coarse and hard for feeding. (Plate IV.)

(6) Tall oat grass, *Arrhenatherum elatius*, 2 acres. This grass grows in bunches, leaving fully one-fourth of the ground bare; otherwise it is very satisfactory, standing 3 to 4 feet high. The entire crop was saved for seed.

(7) Three species of beard-grass, *Andropogon provincialis*, *A. Hallii*, and *A. scoparius*, sowed in 1890, have improved in quality and quantity each year, but are not as promising as those above named. (Plate V.)

Of twenty species of grasses, each occupying a small area, nearly all give indication of profitable culture. It is evident that when the land has been more completely subdued by longer cultivation they will do much better.

OTHER FORAGE PLANTS.

(8) Alfalfa, *Medicago sativa*, 11 acres. This forage plant recovered fully from the drought of last year and yielded 1 ton per acre for the first crop. The second crop, quite as good as the first, was destroyed by the grasshoppers.

(9) Sanfoin, *Onobrychis sativa*, 1 acre. This forage plant bears the drought well, but here makes a better pasture than a hay crop. It was badly injured by the grasshoppers.

(10) Goats-rue, *Galega officinalis*, and kidney vetch, or lady's fingers, *Anthyllis vulneraria*, leguminous plants from France, are most excellent forage plants, resisting the drought, but this season they were destroyed by the grasshoppers. (Plates VI and VII.)

GRAINS.

(11) Arctic rye, 43 acres, yielded 26 bushels per acre.

(12) Red Texas oats, 5⅝ acres, yielded 420 bushels, or 71½ bushels per acre, weighing 37 pounds per bushel. This extraordinary result I attribute to the manner of cultivation. The ground was plowed 1 foot deep, and thoroughly harrowed and pulverized. For the purpose of testing the value of this treatment, I had put in 1 acre of the same kind of oats, with the ground treated in the ordinary manner, namely, plowed about 4 inches deep and harrowed. This acre was immediately adjoining the other field, and was sowed with the same kind of seed. On this acre we harvested 18 bushels of oats that weighed 32 pounds to the bushel.

(13) Algerian wheat, 6 acres. This yielded 147 bushels, or 24½ bushels per acre, and weighed 64 pounds per bushel.

(14) Polish wheat, 10 acres. It gave us 205 bushels, or 20½ bushels per acre, weighing 60 pounds per bushel.

(15) Black hulless barley, 3 acres. It yielded 70 bushels, or 23⅓ bushels per acre, weighing 66 pounds per bushel.

(16) White Algerian barley, 4 acres. This yielded 144 bushels, or 36 bushels per acre, weighing 48 pounds per bushel.

The amount of rainfall on the above-named cultivated crops, from the time of sowing to the time of harvesting, was $8\frac{12}{100}$ inches, which is $\frac{4}{10}$ of an inch less than the average amount for the same time, counting the past 16 years.

(17) Jerusalem corn, 30 acres. The yield of seeds was 900 bushels, or 30 bushels per acre, weighing 58 pounds per bushel. The first planting was the last week in May, and it failed to come up. The second planting was during the last days of June and the 1st of July, and it was harvested the first week in November. The amount of rainfall on this crop was only $5\frac{34}{100}$ inches.

I am doing what I can to introduce this corn, or sorghum, as an article of food, and I think that in another year there will be a good demand for the meal for bread-making.

Sweet clover, or Bokhara clover (*Melilotus alba*). We find that this is a sure crop here, and will yield at least two cuttings. At first we regarded it as worthless for fodder, but further experiment was made by cutting it early, about May 20, for the first cutting, and we found that our horses and mules ate it with a relish. In fact they ate no other hay for two weeks, and they certainly thrived on it.

I have put up a baled-straw barn on the 160-acre lot, so as to keep the teams there during the working season, and thus to economize time. The barn is 20 by 40 feet, 10 feet high. It has a thatched roof, and the total cost, exclusive of labor, does not exceed $15. (Plate VIII.)

EXPERIMENTS ON EVAPORATION.

Some carefully conducted experiments were made to determine the rate of evaporation under different conditions. A number of sheet-iron vessels were made, 1 foot square at the top and 1 foot deep. These were all filled with soil prepared for the purpose, and then sunk in the earth so as to be level with the surface, each one being accurately weighed. They were set on the 1st of August. A certain number of these vessels were covered, each with a mulching of one-third of a pound of oat straw, and an equal number were left exposed, or without any mulching. The 15th of September these vessels were taken up and weighed. The difference in the evaporation between the mulched soil and that without mulching was 9 pounds, equal to more than 190 tons per acre.

TREE-PLANTING.

Of the 2,200 trees planted around the 160-acre lot, as a wind-break (in four rows), all are living and made a marvellous growth, except about 50 trees which were completely destroyed by grasshoppers. They were entirely stripped of bark and foliage. The trees have been thoroughly cultivated during the season and were mulched this fall with a layer of rye straw about 1 foot thick.

MODE OF CULTIVATION.

The land for the cultivated crops was plowed not less than 1 foot deep. This furnishes a reservoir for the rain. Then the surface was made as fine as possible with a harrow having 1,600 small, short teeth This pulverized soil prevents evaporation and conserves the moisture. On the whole the results of the experiments made and the work done are gratifying and satisfactory.

The above report of the work of the Garden City experiment station could hardly make a better showing if it were for a well-cultivated farm in the eastern part of the State. The evidently flourishing condition of the crops and the excellent average yield has attracted the attention of the surrounding country, and the station has had many visitors to witness the progress of the work. It is situated in the semiarid region, which was a few years ago rapidly settled, and as rapidly abandoned by many of the settlers on the bursting of the boom, leaving that country again almost in the condition of a desert. Yet a few thoughtful men, experienced in the physical and climatic conditions of the country, retained hope in its resources, since here and there throughout the dry region there were farmers who had succeeded nearly every year in securing remunerative crops.

Early in September, 1892, a reporter connected with the Denver News visited the station, and in that paper was published an account of what

he saw and what he thought. His account occupies over a column of the paper, and is so impartial and thorough as to be worthy of attention. The following extracts are made from his report:

Garden City is a very pleasant and inviting Kansas town located on the line of the Atchison, Topeka and Santa Fe road, in the Arkansas valley, some 60 miles east of the Colorado State line, in longitude 101° west. It now contains some 1,200 inhabitants. It is surrounded by a typical plains country, the river being dry a portion of the year. The soil of the valley and adjacent plains is fertile, but, being in the arid region, irrigation is necessary to successful agriculture. One or two ditches have been taken out of the Arkansas, and afforded a supply of water during the earlier part of the season. When the river runs low, I was informed that "You Colorado fellows get all the water." In any event, Garden City is the most eastern point in the Arkansas valley where irrigation is at all practiced. With an assured water supply, however, a most productive agricultural section would soon exist here.

The town is still suffering from a "boom," which, early in the eighties, was the biggest thing of its kind on earth. Judged by its harvest of blighted hopes, ruined prospects, and bankrupt fortunes, the men who started it were criminals and the victims who fell within its fatal spell were lunatics. Real estate went to fabulous prices, while all imaginable schemes and enterprises on paper were projected. The result was that many fine business blocks and two great hotels that would do credit to Denver were constructed. A sewer system was put in and waterworks erected and many improvements completed, which were far beyond the capacity of the town to maintain even with the 6,000 or 8,000 people that it had at that time. I saw one elegant brick residence that would adorn Capitol Hill, and which cost $35,000, which now rents for $8 per month. It would take a column, however, to tell the story of the boom. It finally burst, as they all do, and Garden City has not yet recovered from the fitful fever of those days. It is evidently destined to be a pleasant western village that will reflect in its growth and trade and activity the development of the country by which it is surrounded.

The principal object of interest in the vicinity of Garden City is the Government experimental forage farm, which is located some 2 miles from the business portion of the town. It comprises 240 acres, one tract of 80 acres and one of 160 acres.

The improvements on the 80-acre tract consist of a neat and substantial one-story frame house of six rooms, a frame barn, a granary, a tool house, and a straw barn. On the 160-acre tract a straw barn is being constructed. Both tracts are fenced. On one side of the 80-acre tract are rows of cottonwoods, while about the other are two or three rows of black locust, all of which are growing finely. The straw barns mentioned are curiosities in their way. The first one was built on the 80-acre tract. Baled straw was used, each bale being securely fastened by wooden pins. These bales form the sides and ends of the barn, it being covered with a good shingle roof. It makes a safe, economical, durable, warm structure, and is especially adapted to a country where cold piercing winds sweep the plains in the winter and hot suns beat down in summer. The second one, which is on the 160-acre tract, is now being constructed. The roof and gables on this one are being thatched, and it presents a most unique appearance. There is actually no wood about it save the window frames and doors. Farmers who have more straw than money are advised to take a hint from these facts.

After a review of the grain crops, grasses, and other forage plants, he proceeds as follows:

The most successful variety of corn is known as Jerusalem corn. I saw 30 acres of it, and never looked at a finer field of corn west of the Missouri. It looks green and rank, produces an abundance of excellent fodder, and yields well of the grain, which is equal in all respects for feeding and fattening to Indian corn. It maintains a rapid growth and matures early, and I see no reason why it should not be adopted as one of the favorite and profitable crops of the plains country.

Of seventy-five or more varieties of grasses which have been experimented with, three are thought to be undoubtedly adapted to culture on the plains. The first of these—and by all odds the best—is the bromus grass. The first experiment with it was on a patch of ground 4 or 5 rods square. It did so well that there are now 20 acres of it under cultivation. It makes a most excellent hay and yields largely to the acre. It also makes a fine pasture grass. As I saw the field since it has been cut and the hay stacked, it looks green and will furnish a large amount of pasturage. I am certain that no grass yet tried on the plains is better adapted to successful growth.

The next in favor is known as the Colorado redtop, which makes even a better hay than the bromus, but is not so well adapted for pasture. The third is the blue stem, which is most popular with Colorado stockmen, and which makes both a good

hay and a good pasture. All of these grasses, it is believed, can be grown with profit and success in the arid region. In the experiments it is found that the grasses do better when sown upon land that has been previously cultivated, and from which a crop or two of grain has been taken. The forage grasses do not thrive well on fresh broken prairie sod.

The value of these experiments, and the fact that they can be duplicated by all practical farmers, lies in the fact that the results gained have been wholly without irrigation, and from land which fairly represents the arid region. What has been done about Garden City can be done all along the line of western Kansas, and western Nebraska, and in eastern Colorado. The culture is neither expensive nor impracticable—it is simply intelligent and thorough—and these two characteristics must be prominent in any system of agriculture that may prevail within the lines of the arid region. If, for instance, certain varieties of oats, wheat, barley, and corn can be produced on this dry Government farm, as the result of deep plowing, they can also be as successfully grown by any intelligent and industrious farmer who will do the same thing—plow deep. The results given above can be also achieved by anyone who is willing to comply with the necessary conditions; if he is not, he is certain to fail, and the sooner he quits farming and gets out of the arid region, the better it will be for all parties concerned.

The future of this great plains country lying between the line of sufficient rain on the east and the line where irrigation is possible on the west has for many years been the matter of serious consideration. I can never believe that it was always intended to be a sparsely populated waste. It must be made to subserve some good industrial purpose. There are those who believe that "the rains follow the plow," and to a certain extent this is true. But that the arable line will advance westward until it meets the irrigated fields of Colorado I do not believe. There will, for many generations to come at least, be a deficiency of rainfall in this region, and to meet this fact certain varieties of grain, grasses, and forage plants must be adapted to existing conditions, and to aid in ascertaining what these are the experimental farm at Garden City exists.

Were a varied agriculture, such as is found in the East or under the benign influences of irrigation, possible on these plains, there would be no special necessity for this expenditure of money on the part of the Federal Government; but it is not possible, and the question is, What profitable purpose can they best subserve? I observe that the arid region, beyond the line where irrigation can be practiced, can be utilized as a semipastoral region, where the farmer must look to his cattle, fed upon these forage plants and grains which shall be found adapted to growth upon the plains, for returns for his labor rather than to grain or any of the other products of a varied agriculture. This industry is the legitimate successor of the range cattle business. With the products of 80 acres devoted to bromus grass and redtop, to red Texas oats, and Jerusalem corn, a farmer can raise, feed, and fatten many head of horses, cattle, sheep, and hogs, and find for them a profitable market. And this I believe is the future industry of these arid plains.

With reference to the straw barns mentioned it may be useful to give some details regarding their construction. These, in the words of Mr. Sewall, are as follows:

The first thing to do is to bale the straw; then level the ground for a foundation, and lay down two 2x4's; then lay the first tier of bales on these.

Make hardwood pins or dowels 8 inches long and about an inch square, pointed at both ends. Drive four of these (one in each corner) into the bale half the length of the pin. Lay the second tier, breaking joints as in brick work, pressing the bales on to the pins, and so on until you have made the walls as high as you wish, say, 8, 10, or 12 feet.

Put in window and door frames wherever you want them. These should be made of 2-inch plank, 10 inches wide. On the top of the last tier of bales lay planks 8 inches wide and bolt with wooden pins 2 feet long.

On these planks or plates nail the rafters. The roof and gable ends may be boarded and shingled; or boarded with 6-inch boards, placed 10 inches apart, and thatched with straw.

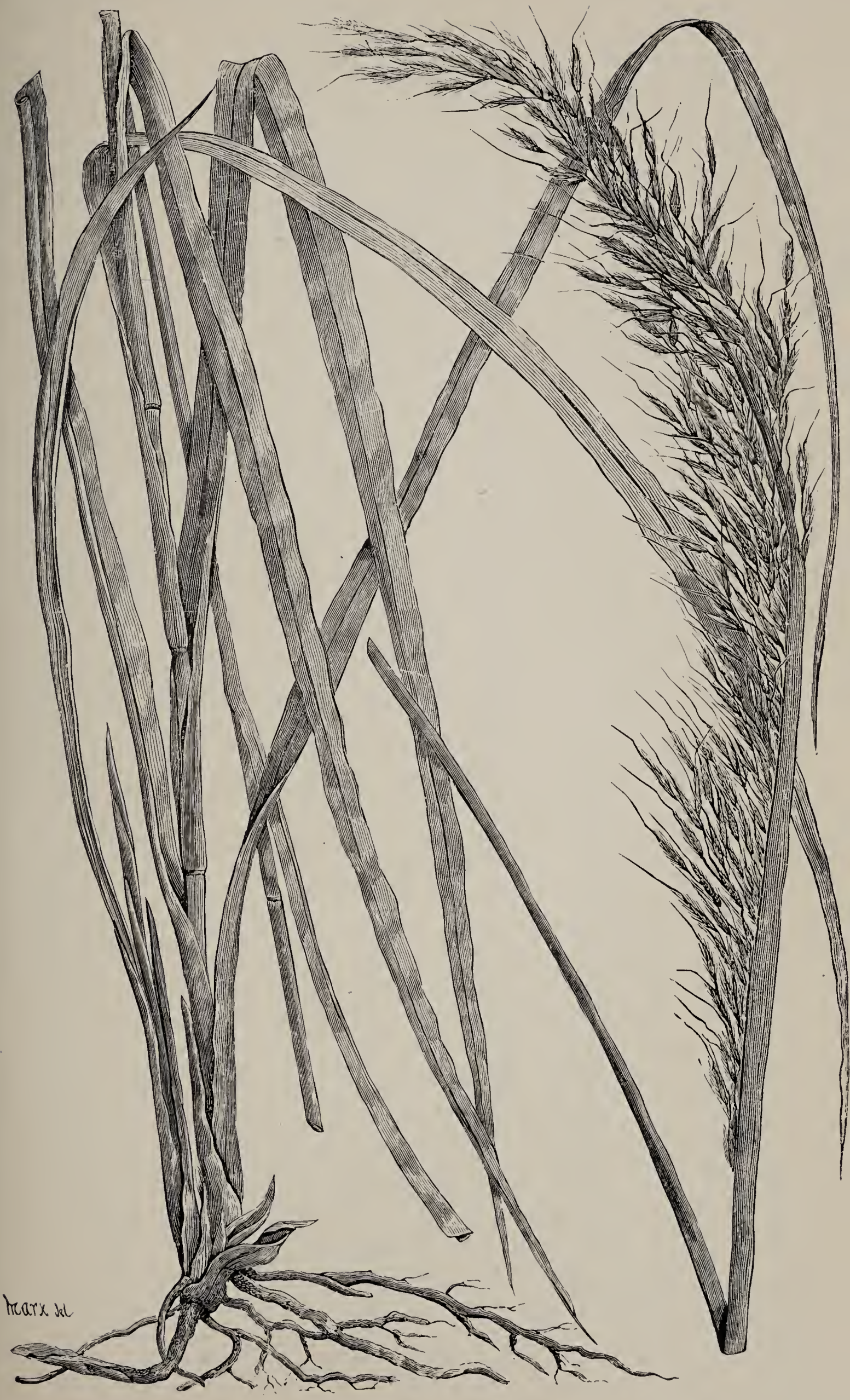
A barn may be built of any size in this way. Those at the United States experimental grass and forage station at Garden City are 20 by 40. One is 12 feet high, with a loft for hay; the other is 10 feet high, with roof and tall gables. The cost is about one-third that of a barn constructed of lumber.

These barns are cheap, durable, and adapted to the plains country. There should be hundreds of them in the arid region, as any intelligent or practical farmer can build one at his leisure and not only utilize his straw, which would otherwise go to waste, but provide the best shelter for his stock and farm machinery.

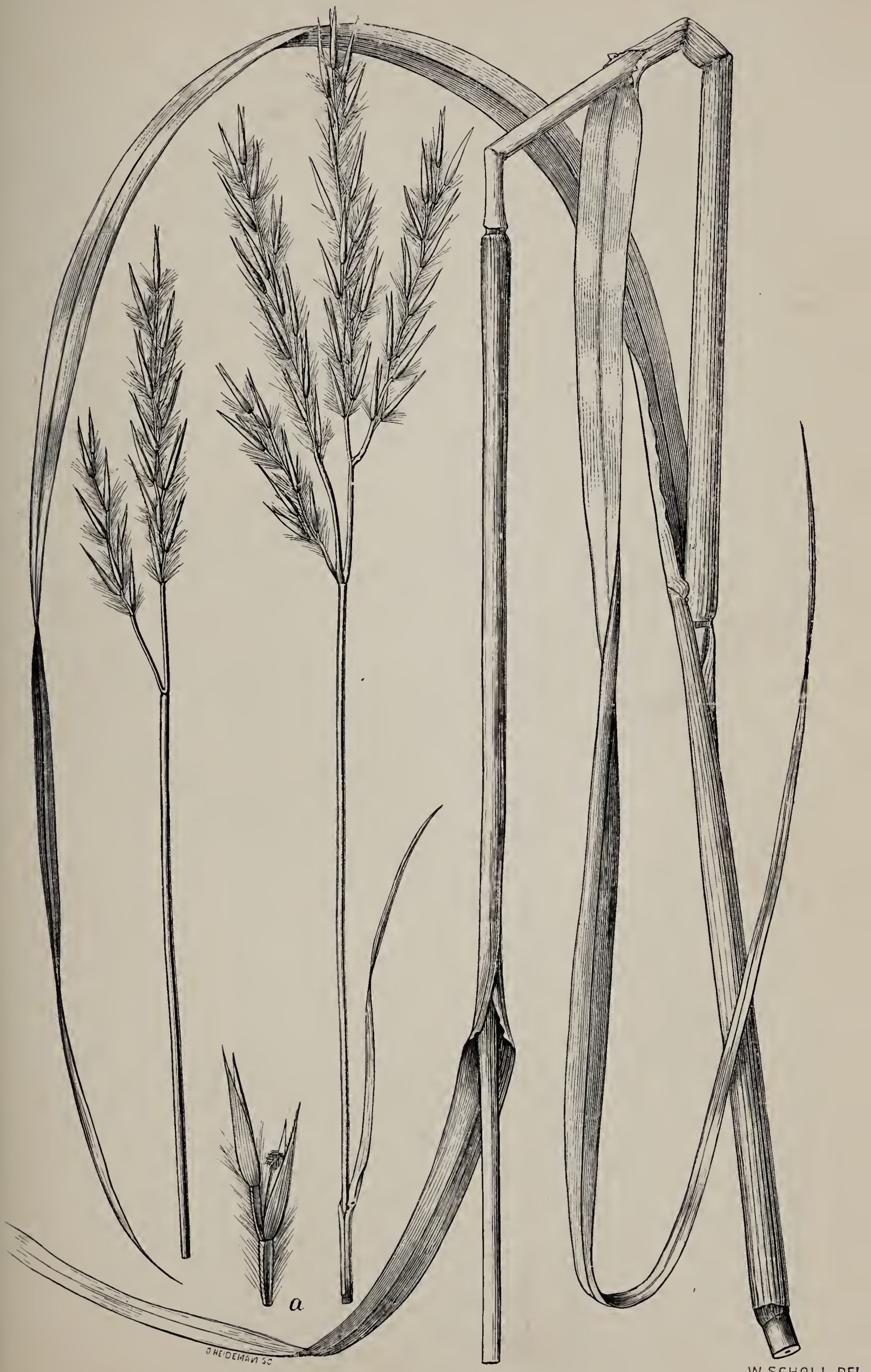
PANICUM VIRGATUM.

BROMUS INERMIS.

AGROPYRUM GLAUCUM.



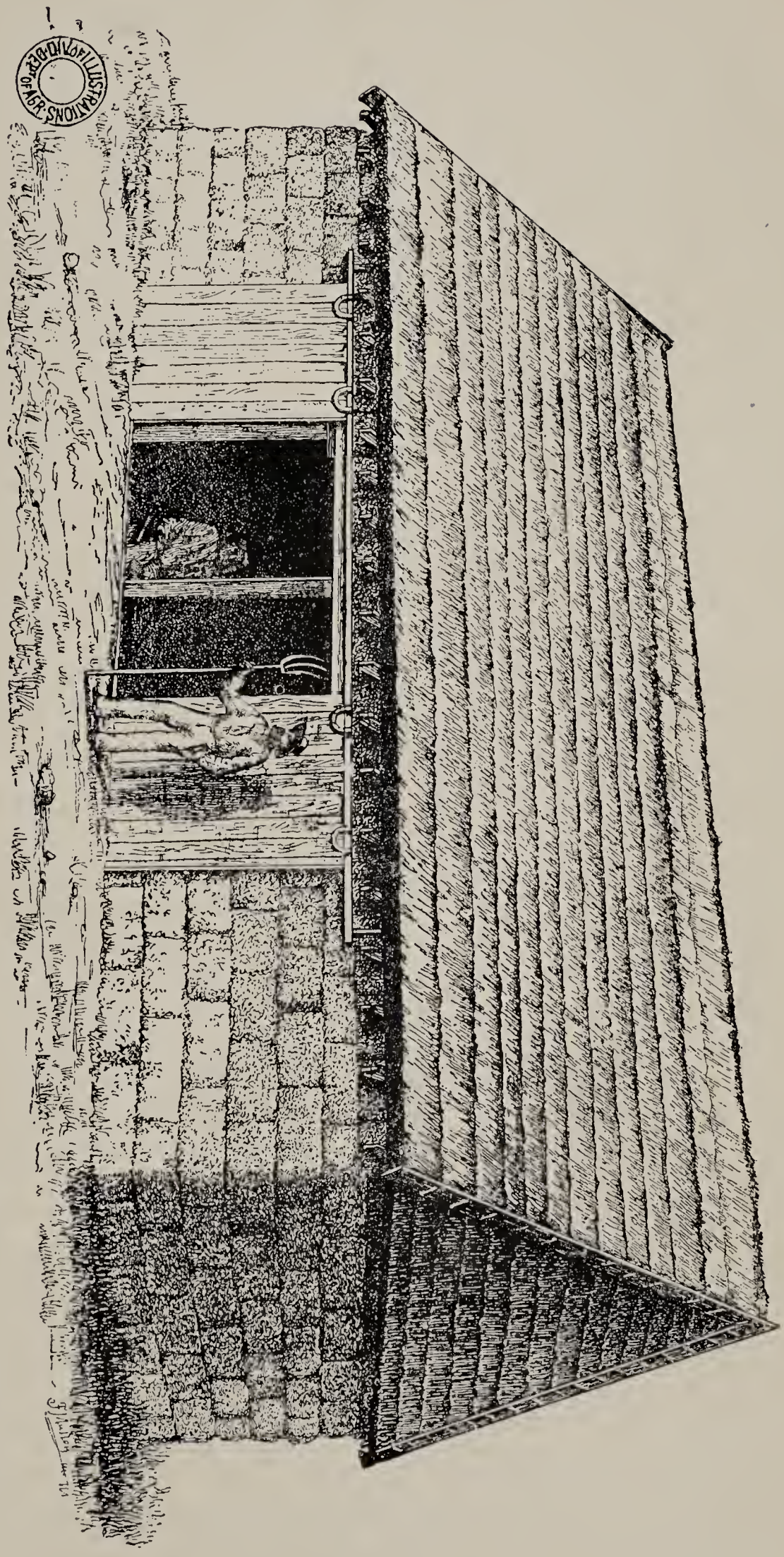
CHRYSOPOGON NUTANS.



ANDROPOGON HALLII.

GALEGA OFFICINALIS.

ANTHYLLIS VULNERARIA.



BARN OF BALED STRAW.

COÖPERATIVE BRANCH STATIONS IN THE SOUTH.

By S. M. TRACY, *Superintendent.*

In the Report of the Secretary of Agriculture for 1891, an account is given of the establishment in 1888 of a station for special work with grasses and forage plants in Mississippi, and of the establishment, in 1891, of other stations in North Carolina, Georgia, Florida, and Louisiana for similar work. The appropriation for the present year having been greatly reduced from the amount provided in previous years, the work in North Carolina and Florida was dropped, but that in Georgia, Louisiana, and Mississippi is still continued.

In the South there is no scarcity of hay-producing plants, and good forage is abundant during the summer and autumn months, but in the winter and early spring the fields are nearly bare and the pastures of native grasses are almost worthless. Lespedeza and Bermuda grass, the two great forage plants of the South, begin their annual growth only after the advent of summer, and are killed to the ground by the first severe frost. While they grow, they thrive with such luxuriance as to crowd out most other plants, and so, when they are killed by frosts, the fields are left with very little forage until the warm weather of the next season.

From the fact that comparatively few cattle are kept in the South, and that the few which are kept are seldom stabled, the Southern farmer has very little stable manure for use on his cultivated fields, and must therefore look to other sources for his fertilizers. The work of the various experiment stations has clearly shown, that for the lime lands and the piney-woods region of the South it is much more economical to grow the fertilizers in some crop suitable for plowing under than to purchase them, either in the form of chemicals or as cotton-seed meal. With these two important conditions in view, it has been the effort of these Southern grass stations to find—

(1) Such plants as would yield a fair amount of pasturage during the winter and early spring months; and

(2) To find such plants as would be of the greatest value for fertilizing purposes, and would also give fair returns, either as hay or as pasture plants.

With these ends in view, the stations have planted seeds of 495 species of grasses and forage plants, procured from nearly all parts of the world. Most of these have been planted at each station, and many at two or more stations for several seasons, on soils of very different characters. As was to be expected, most of those tested have proved of little or no value when grown under the peculiar climatic conditions which obtain throughout the South. A few, however, are growing finely and promise to become valuable additions to our list of hay and pasture plants, while others are being recognized as important factors for restoring fertility to soils which have become exhausted by continued cultivation in cotton and corn. Among the more promising of these are the following:

HUNGARIAN BROME (*Bromus inermis*).—This is nearly related to the well-known "rescue-grass," but is decidedly superior in its more permanent character and its ability to thrive on drier and less fertile soil. It starts into growth with the autumn rains, and is fresh and green during the winter months, being uninjured by our heaviest frosts. It

forms a compact sod so firm as to prevent the growth of other grasses and weeds, and the yield of forage is larger than from any other winter grass we have tested. It is eaten well by all kinds of stock, and continues in good condition well into the summer. It produces a dense mass of leaves a foot or more in length, which make the finest of hay, though the stems are short and the yield of hay is small. It is preëminently a winter grass, and as such we regard it as being the most valuable grass which we have imported.

TEOSINTE (*Euchlæna luxurians*).—This plant needs a long season of hot weather, a rich soil, and abundant moisture to succeed well, and it is useless to plant it except where all these conditions can be had. It has done fairly well at the Mississippi and Georgia stations, very little in North Carolina, and has made a heavier crop than any other plant which has been grown at the Louisiana station. In Mississippi, the heaviest yield secured has been 22 tons per acre, while the Louisiana station reports the enormous yield of 55 tons of green forage per acre. The plant makes from forty to sixty shoots from a single seed; and, as these grow from 10 to 12 feet high, they are so crowded that the stalks are small and a very large proportion of the bulk consists of leaves which, pound for pound, have a fodder value fully equal to that of sorghum. Its value for feeding purposes is seen in the fact that the entire crop grown at the Louisiana station was sold to a local dairyman at the rate of $2 per ton while standing in the field. There is probably no better plant than this for soiling purposes, as it starts very quickly after cutting, and in the extreme South will give three or four heavy cuttings each season. The seed matures well at the Louisiana station, but has never done so in Mississippi.

CRAB GRASS (*Panicum sanguinale*).—In the Northern States this is regarded as a troublesome weed and wholly worthless as forage, but in the South its character is very different, and it has great value for hay. It makes a heavy growth on lands from which wheat, oats, or other early crops have been harvested, and on good soils will yield 2 tons per acre of hay which, if cut before it is too ripe, is fully equal to the best timothy. On land which was plowed in February we have cut four crops of about 1 ton each in a season. As its best growth is made in cultivated fields, and at a season when other crops are not abundant, it is of considerable value for grazing; and as the hay made from it is of excellent quality and costs nothing but the cutting, it is highly prized by many planters, especially near the Gulf coast, where it is usually mixed with Mexican clover (*Richardsonia scabra*), which is equally valuable.

COW PEA (*Dolichos sinensis*).—It is often desirable to plow under some green crop when it is impossible to give up the land for the one or two years necessary to grow a crop of red clover or melilotus. In such cases we have no other plant which is so desirable as the cow pea. It may be sowed at almost any time during the summer, will grow on any soil, and makes excellent hay or pasture; while the long deep roots bring a large amount of plant food from the subsoil and leave it near the surface, where it is available for succeeding crops. One of its great merits is that it can be grown successfully under varying circumstances, and that when the seed is put into the ground with even ordinary care a crop is the sure result. Many planters use the bunch varieties for planting between the rows of corn or cotton at the last plowing. When sowed in this way they do not interfere with the growing crop, will give a fair yield of seed, and the decaying vines make a most excellent covering for the soil during the winter. By spring the

roots and vines will be thoroughly decayed, and by reversing the beds so as to bring the rows of cotton this year on the rows where the peas grew last year, the crop is largely increased and no time is lost. When sowed in this way they are difficult to gather for seed, but make the best of fall pasture, and the droppings from the cattle fully repay the loss of the vines.

When sowed broadcast after oats, wheat, or some other early crop, the running sorts make a heavy yield of hay, which, although somewhat difficult to cure, is of the very best quality. By growing such a crop, hay is made at a very small expense, while the soil is shaded during the driest and hottest months, and left loose, mellow, and in the best possible condition for any future crop. The roots penetrate the soil as deeply as do those of red clover; and this fact makes the crop an especially valuable one for heavy and seepy soils which need draining. When land is not in use otherwise for even two months during the summer or fall, it will always pay well to seed it to peas, as the seed which can be gathered will fully pay the cost of cultivation and give the fertilizing value of the crop as a clear profit.

MELILOTUS (*Melilotus alba*, Bokhara clover, sweet clover).—This plant bears a close resemblance to alfalfa, but is larger and coarser in every way and is especially adapted for use on calcareous soils. It will make an excellent growth on any lime lands, even on "rotten limestone" hills which are so barren that they will sustain no other plants, but is of almost no value on the red clays, which contain but little lime. It is not generally liked by animals unaccustomed to its use, but it starts into growth very early in the spring, when green forage is scarce; and if stock are turned on it at that time they very soon acquire a taste for it and eat it readily through the remainder of the season. When grown for hay, one and sometimes two crops can be cut in the fall after sowing in the spring, and during the next season two or three crops may be cut, after which it should be allowed to mature seed. Unless cut early the stems become hard and woody, and in all cases care is necessary in handling in order to prevent the loss of leaves, which drop from the stems very easily. Excellent hay can be made by sowing melilotus on lands which have been set in Johnson grass, the mixture seeming to improve the palatability of both. From land cultivated in this manner we have seen three cuttings, of about 2 tons each per acre, made in one season.

As a restorative crop for yellow loam and white lime lands, this plant has no superior, and for black prairie soils it has no equal. Most of the black prairie soils are still rich in plant food, and during the early part of the season cotton makes a rank growth on them and promises a heavy crop; but with the August and September droughts the bolls drop from the stalks, and the crop is far less than is expected from the rank growth of the plant. The use of ordinary fertilizers seems to have little effect on such soils, and the trouble with them appears to be in their mechanical condition rather than in their want of plant food. Draining with tile has worked well where we have tried it, but this is too expensive to be generally adopted, and we have found the growing of an occasional crop of melilotus to accomplish fully as good results.

The expense of seeding land to melilotus is less than for seeding to oats, the crop is a profitable one either for hay or for pasture, and at the end of the second year the land is left in the best possible condition for any succeeding crop. The roots of the melilotus are long, penetrating the soil to a depth of 3 or 4 feet, are quite large, and by

their decay at the end of the second year leave the soil with innumerable minute holes, which act as drains to carry off the surplus water, and loosen the soil so that the roots of other plants can go deeper and find more abundant supplies of food. Melilotus is one of the few plants which are able to draw their supply of nitrogen from the air, and so, by its decay, it furnishes the most valuable and expensive ingredient of commercial fertilizers free of cost, and in the best possible form.

The hay from this crop will not sell as well as that from lespedeza, but the crop is heavier, will furnish more pasture, and is by far the most valuable crop we have for a natural fertilizer.

ALFALFA (*Medicago sativa*).—This plant has failed to produce satisfactory yields at any of the stations except the one in Louisiana, where it is planted on the alluvial lands near the river and where its growth has been unusual. At that station, the first sowing was made in October, 1890, and in June, 1892, twenty months after planting, fourteen cuttings, averaging nearly 1¼ tons per acre, had been taken from the land. Another field, sowed in March, 1892, had given three cuttings by the end of June. At the Mississippi station a field was sowed in 1889 which gave three cuttings of about 1½ tons each per acre in 1890, while in 1892 the yield had decreased to three cuttings of only about 1 ton each. A thoroughly drained soil, with an abundance of moisture, seems necessary to its successful growth.

HAIRY VETCH (*Vicia villosa*).—The seed of this plant was first sowed in October, 1888, and since then has given heavy annual crops on the same ground, although it has received no attention and the ground has not been plowed since the first sowing. In 1889, another field was sowed and has given equally good results. It is an annual which bears a close resemblance to a very slender pea vine, and which makes its entire growth during the cooler months. The seeds germinate with the first autumn rains and, in a favorable season, the ground will be well covered by January 1. At this date, December 12, the plants at the Mississippi station average about 6 inches in height, and will afford good grazing in January. If not pastured, the vines will reach a length of from 10 to 12 feet in May, when the seed will ripen, and by July the plants will have disappeared. Stock eat the vines greedily, but should be taken off the field by the first of April, to give the plants an opportunity to mature a crop of seed. If the stock is taken off in time so that even a moderate crop of seed is procured, the land will not need plowing or reseeding for the next season. For winter grazing we regard this as the most valuable plant we have ever seen, while for fertilizing purposes it is fully equal to the cow pea.

From our experience during the past five years, we do not expect to find any one plant which can be regarded, under all circumstances, as being "the best" for either hay, pasture, or fertilizing purposes. To secure the best results for either purpose, we must use a mixture of two or more sorts which make their maximum growth at different seasons; and one of the species used should be a leguminous plant, in order that the land may become better prepared for succeeding crops. The selection of the sorts must vary with the character of the soil on which they are to be planted, the length of the growing season, and the amount of moisture in the soil. Most of the true grasses are affected more by moisture than by other differences in the soil, while most leguminous plants are affected more by the amount of lime present. For general cultivation in the South for hay, we regard Bermuda grass, lespedeza, Johnson grass, red clover, and crab grass as the five best

species, and value them in about the order given. For winter grazing, we have found nothing better than hairy vetch, Hungarian brome, orchard grass, rescue-grass, and burr clover. For the region near the Gulf coast, alfalfa should be added to the list of hay plants, and carpet grass (*Paspalum platycaule*) to the list for pastures; while at the Carolina and Georgia stations wonderful results have been secured by the growth of crimson clover. If the crop is to be grown partly for hay or pasture and partly for its fertilizing effect on the soil, there is nothing equal to the cow pea and winter vetch for immediate effect. If the land is not to be plowed for a year or more, the winter vetch and melilotus, red clover, or lespedeza are our best plants. If the land contains an excess of lime, melilotus will be the better crop, but if deficient and somewhat barren, lespedeza will succeed better. On lime soils which are already in fair condition, red clover will give excellent results as a fertilizer, and will also give two or three crops of hay which will be of more value than that from either melilotus or lespedeza.

The work of the Southern grass stations is demonstrating clearly—

(1) That hay, equal to the best in quality, can be produced here at less expense than in any other part of the country;

(2) That by using a proper selection of varieties, good pasturage can be secured during at least ten months of the year; and

(3) That by growing leguminous crops for hay and pasture, a large proportion of the money now expended in the purchase of commercial fertilizers can be saved.

THE RUSSIAN THISTLE.*

The Russian thistle or Russian cactus (*Salsola kali* var. *tragus*) is really neither a thistle nor a cactus. Saltwort is its true English name, but to the farmers of the Northwest, who are best acquainted with the plant, it is known as the Russian thistle.

The weed is an annual, growing to a height of 6 inches to 3 feet, branching profusely, and when not crowded forming a dense, bush-like plant 2 to 6 feet in diameter and one-half to two-thirds as high. When young, it is tender and juicy throughout, with small, narrow, downy, green leaves; but in late summer it sends out hard, stiff branches which bear, in place of leaves, sharp spines, one-fourth to one-half inch long. At the base of each cluster of spines is a papery flower about one-eighth inch in diameter.

The Russian thistle takes possession of a field to the exclusion of everything else, drawing from the land a large amount of nourishment. It is armed with spines quite as sharp as those of the Canada thistle and much stronger, so that in some sections the farmers find it necessary to bind leather about the horses' legs while at work. It is the worst tumbleweed of the plains, and in time of prairie fires is easily blown across a fire-break of any width, carrying fire to stacks and buildings.

The plant originated in eastern Europe or western Asia, and in Russian wheat fields has quite as bad a reputation as in those of the Dakotas. It was introduced into Bon Homme County, S. Dak. about fifteen years ago, probably in flaxseed imported from Europe. By the year 1892 it has become more or less common over all the region between the Missouri and Jim rivers in South Dakota, extending into North Dakota as far as the second tier of counties. A district of about 30,000 square miles is infested with the weed, which has become a pest

*Abstract of Farmers' Bulletin No. 10.

throughout two-thirds of this area. More than 640,000 acres of the badly infested region is devoted to wheat-raising, and the total loss caused by the plant in 1892 is estimated at more than $2,000,000.

The Russian thistle grows best on high, dry land. The plants are less numerous and robust in wet than in dry seasons, not because they cannot stand wet weather, but because they are more crowded by other plants. The thistle appears to grow equally well in alkaline and nonalkaline soils. The absence of trees and fences, the strong winds, and the methods of farming followed in the Northwest are particularly favorable to its distribution and growth. The policy of growing only a few very profitable crops has induced the farmers to break up a larger area than they can work well. Wheat is sowed over acre after acre, sometimes merely drilled in on the furrow, or even on unplowed stubble land. Where whole sections and even townships form one continuous wheat field, an acre here and there so grown up to weeds as not to be worth harvesting, does not seem to be of much importance; but it is in such places that the principal development of thistle seeds for the succeeding year takes place. Plowing in the spring or early summer is especially favorable to the growth of the Russian thistle, since it then obtains a thorough foothold in July, and, being able to stand dry weather better than other plants, takes complete possession of the soil.

The following remedies are recommended: Plow in August or early September, before the weeds have grown large and stiff and before they have gone to seed. If the season be long and the plants come up through the furrow, it may be necessary to harrow the land before winter. Burn over stubble fields as soon as possible after harvest, and cut the stubble with a mowing machine if the fire does not burn everything clean. If the weeds have been neglected and have grown large and rigid, as they do by the middle of September, especially on neglected barren fallow, they may be raked into windrows and burned. This method is to be recommended only as a final resort, for by the last of September some of the seeds will be ripe enough to shell out and will escape being burned with the plants. Barren fallowing does very well if the land is kept barren by thorough cultivation. It gives but little benefit to the land, however. A much better method is to sow clover, millet, or rye, pasture it and plow it under while green. Corn, potatoes, beets, or any cultivated crop, well taken care of, will in two years rid the land not only of the Russian thistle but of nearly all other weeds. Sheep are very fond of the plant until it becomes too coarse and woody. By pasturing sheep on the young thistle it may be kept down, and the only valuable quality the plant has may be utilized. If the Russian thistle is to be kept out of cultivated fields, it must be exterminated also along roadsides, railroad grades, fire-breaks, waste land, wherever the sod has been broken, and in all places where it may obtain an accidental foothold.

Plate IX represents a branch of the plant as it appears in autumn; *a*, a branch of a young plant; *b*, a mature seed, enlarged. A branch of a Russian thistle before flowering is represented in the Report of the Botanist of the U. S. Department of Agriculture for 1891, Plate X.

SALSOLA KALI VAR. TRAGUS.